Suppression of convective precipitation by elevated man-made aerosols is responsible for large-scale droughts in north China

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It has been proposed that the summer "South Flood–North Drought" (SFND) pattern observed in China over recent decades is caused by the relative impacts of global warming, aerosol loading, and natural variability on regional rainfall (1–3). This conclusion is supported by a recent study by Day et al. (4) in which the SFND is attributed to the changes in the frequency of frontal rain events. Using a technique called the Frontal Rain Event Detection Algorithm for the observations during 1951–2007, decadal changes in the amount and distribution of rainfall in eastern China were found to be overwhelmingly due to changes in frontal rainfall (4). Day et al. conclude that frontal rainfall was envisioned as the product of large-scale frontal convergence and the nonfrontal rainfall was because of local convection, orographic rainfall, and typhoon rainfall. The authors further imply that the shifts in frequency and latitude of frontal rainfall over the recent decades in eastern China reflect changes in large-scale atmospheric circulation.

However, Day et al.'s (4) conclusion fails to consider suppression of convective precipitation in north China by anthropogenic aerosols, a critically important factor for the recent SFND in China (5–7). On the basis of the observed summer mean rainfall over China during 1952–2015, Yu et al. (7) found that large-scale rainfall enhancements are persistently occurring in east China (along 27.0°N to 34.5°N, mainly located in Yangtze River Delta) with increasing droughts in north China (along the 34.5°N to 45°N latitudinal band). By cooling the surface and the lower troposphere over the land and stabilizing the boundary layer, the enhanced anthropogenic aerosols suppressed the deep convection, which reduces the condensational heating in the free troposphere and the thermal contrast between the land and ocean over north China (5, 6). The enhancement of the large-scale precipitation in east China and the suppression of the convective precipitation in north China by the elevated anthropogenic aerosols are believed to be responsible for the SFND (5–7).

Although we strongly agree with Day et al.'s (4) finding that decadal changes in rainfall in eastern China (mainly located in Yangtze River Delta) are mainly due to changes in frontal rainfall because of the enhancement of the large-scale precipitation, we do not believe that the large-scale droughts persistently occurring in north China (along the 34.5°N to 45°N latitudinal band) are mainly due to a decrease of frontal rain event frequency. We believe that the suppression of the convective precipitation (i.e., nonfrontal rain) in north China by the elevated anthropogenic aerosols is responsible for this. Further research with the observations and modeling effort is urgent.

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